

Manufacturing Readiness Levels (MRLs)

for
**Multi-Dimensional Assessment of
Technology Maturity**



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Jim Morgan
MRL Implementation Lead
Manufacturing Technology Division
AFRL/MLM Phone # 937-904-4600
jim.morgan@wpafb.af.mil

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Outline



- **Why MRLs?**
- **What are MRLs?**
- **MRL implementation plan**
- **Status**
- **ACAT pilots**



Why MRLs?

Manufacturing & Industrial Base Challenge



- Consensus among Congress, OSD, CSAF, GAO:
"Advanced weapon systems cost too much, take too long to field, and are too expensive to sustain"
- Recent GAO study of 54 weapons programs:
 - Core set of 26 programs: RDT&E costs up by 42% and schedule slipped by 20%
 - \$42.7B total cost growth
 - 2.5 years slip on average
 - Characteristics of successful programs (GAO):
 - *Mature technologies, stable designs, production processes in control*
 - *S&T organization responsible for maturing technologies, rather than program or product development manager*
- Defense Science Board evaluated ManTech roles/impacts for AT&L
 - ManTech can significantly impact across all acquisition phases
 - Facilitates manufacturing/industrial base readiness for S&T transition and acquisition



Technology Readiness Levels (TRLs)



Provide a common language and widely-understood standard for:

- Assessing the *performance maturity* of a technology and plans for its future maturation
- Understanding the level of performance risk in trying to transition the technology into a weapon system application

TRLs leave major transition questions unanswered:

- Is this level of performance reproducible in items 2- 1000?
- What will these cost in production?
- Can these be made in a production environment by someone without a PhD?
- Are key materials and components available?



Manufacturing Readiness Levels (MRLs)



What are MRLs?

- Framework to evaluate “*manufacturing maturity*”
- Complements existing Technology Readiness Levels
- Used to assess maturity and risk of a technology’s underlying manufacturing processes
 - Enable rapid, affordable transition to weapon system programs
- Designed to address manufacturing risk mitigation



DoD MRL Implementation



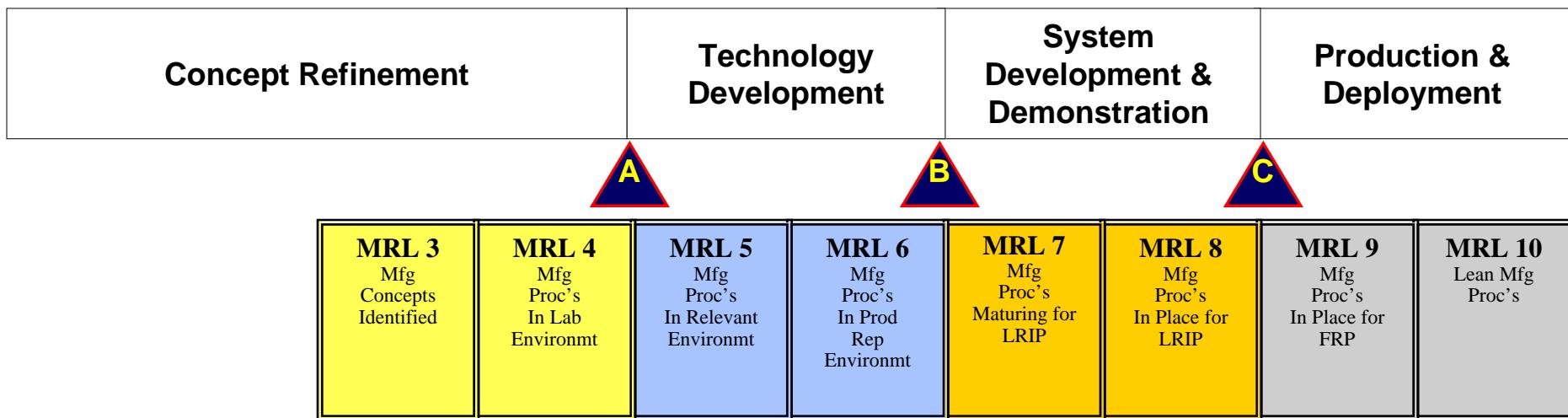
- DoD (AS&C) vision is to develop and institutionalize MRLs
 - Assess the manufacturing maturity of a technology or product and plans for its future maturation; common language to convey status
 - Understand the level of manufacturing risk in trying to produce a weapon system or transition the technology into a weapon system application
- DoD Joint Defense Manufacturing Technology Panel (JDMTP) chartered an MRL Working Group to refine definitions and develop plans to institutionalize MRLs within the AT&L community
 - Government and industry representatives participating
 - Developed definitions that interface with TRLs and milestone decision points
 - Develop implementation strategy consistent with DoD 5000 acquisition doctrine, practice, and milestone decision points
- SAF/AQ
 - Conduct ACAT pilots and then develop policy
- AFRL/CD
 - Implement into all AFRL ATDs



MRL Relationships



Relationship To System Milestones

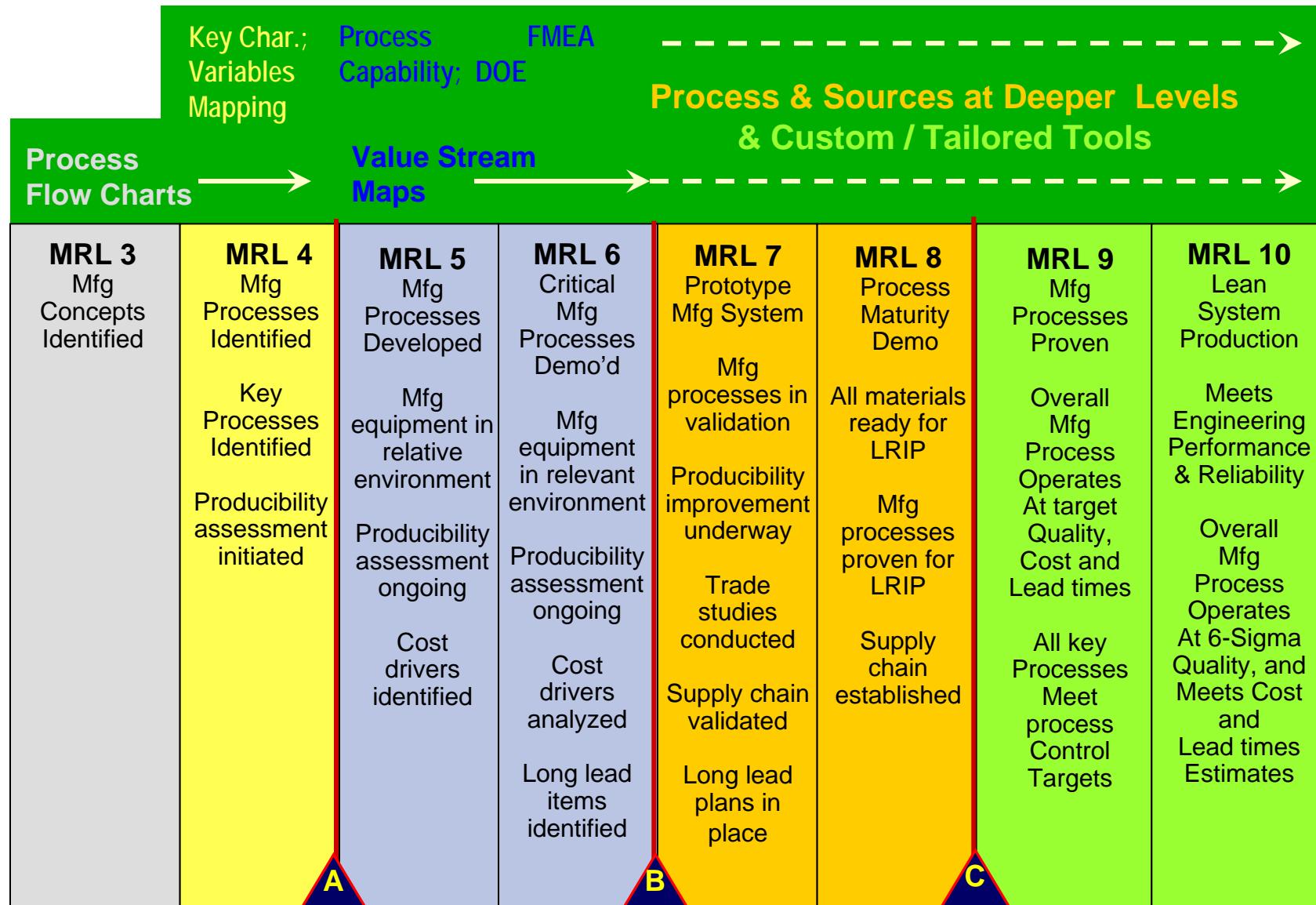


Relationship To Technology Readiness Levels

TRL 1 Basic Principles Observed	TRL 2 Concept Formulat	TRL 3 Proof of Concept	TRL 4 Breadbrd in Lab	TRL 5 Breadbrd in Rep Environmt	TRL 6 Prototype in Rep Environmt	TRL 7 Prototype in Ops Environmt	TRL 8 System Qual	TRL 9 Mission Proven
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MRL Definitions & Tools





Mapping Tools for MRL



MRL

Tools

Use to Evaluate...

3

Process Flow Charts

Basic manufacturing concepts

4

Detailed Process Flow

Key manufacturing processes charts

5

**Value Stream Mapping
and identifying waste**

Mapping the current state

6-10

**Value Stream Mapping
and eliminating waste**

Mapping the future state



Process Control Tools for MRL



MRL

Tools

Use to Evaluate...

4-6 Key Characteristics

Requirements and tolerances

4 Process Variables Map

Which variables to control

**5-9 Process Capability
Performance**

Predictability of process

**5-9 Design of Experiments
independent variables**

Multiple factors and levels of

**6-9 Failure Modes and
Analysis**

Risks associated with failure effects



MRL Evaluation Criteria



- **Technology and Industrial Base**
- **Design**
- **Materials**
- **Cost and Funding**
- **Process Capability and Control**
- **Quality Management**
- **Manufacturing Personnel**
- **Facilities**
- **Manufacturing Management**



What is an ATD?



- Any Air Force science and technology program (6.3)
 - Objective of demonstrating an integrated set of technologies
 - Superior warfighting capability
 - Ready to transition before the end of the FYDP
- Sufficiently mature the technology(ies) for transition into an advanced system development or a fielded system upgrade
- Categories
 - CAT 1
 - MAJCOM/Agency supports and has programmed required funding for transition within the FYDP
 - CAT 2A
 - MAJCOM/Agency supports and is committed to identify transition funding in next programming cycle
 - CAT 2B
 - MAJCOM/Agency supports but is not currently able to POM for transition



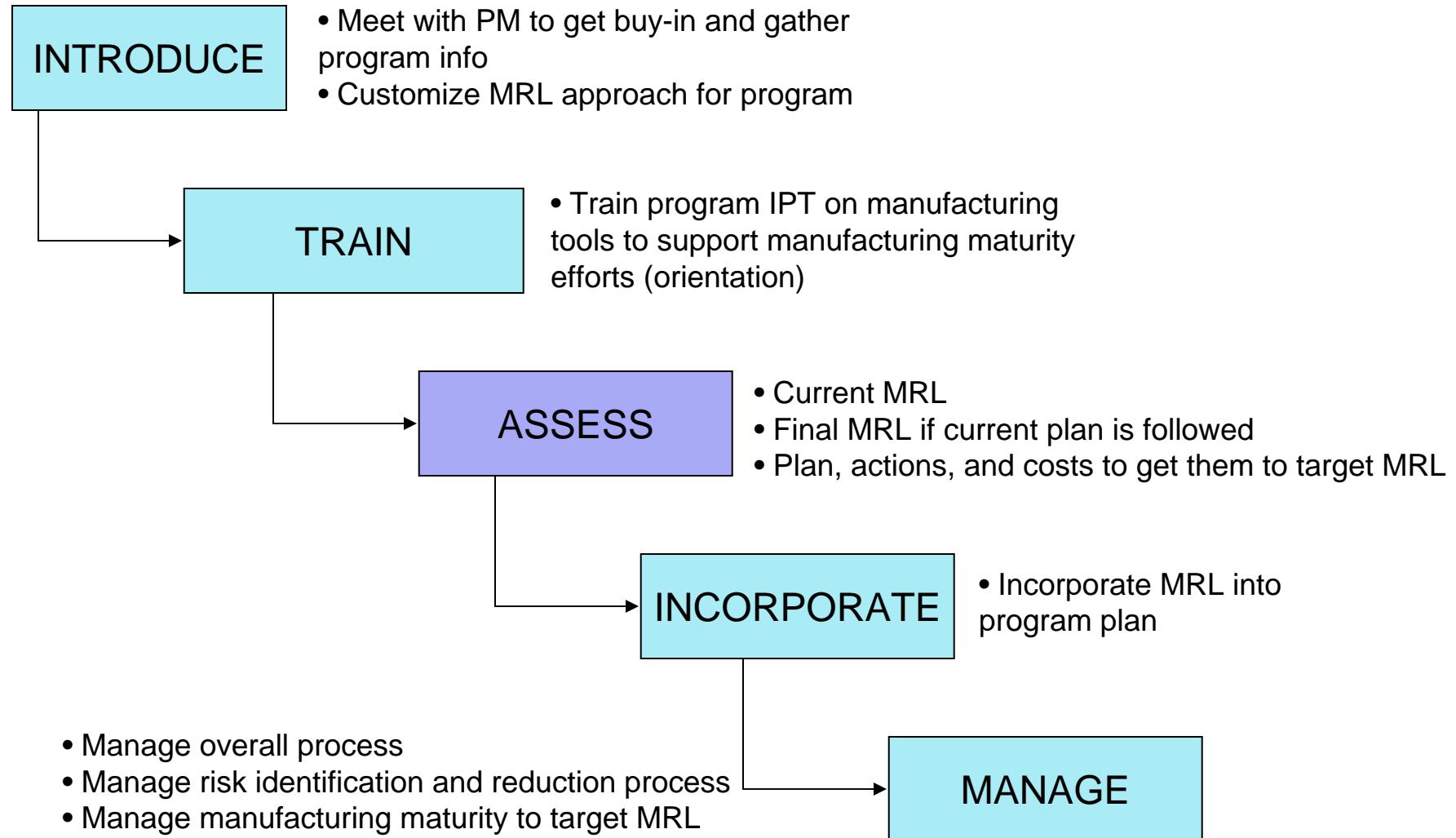
MRL Incorporation into AFRL ATDs



- Conducted ATD pilot assessments on five ATDs
- Tasked to implement MRLs into hardware intensive ATDs
- Developed basic approach/process for implementation
- Developed training for ATD IPTs and ManTech personnel
- Identified core ManTech funding for MRAs and selected follow-on MRL maturation
- Conducted assessments of four additional ATDs
- Currently working with ten total ATDs



ATD MRA Approach





Current ATD Portfolio



- F135 (PR)
- F136 (PR)
- Common Weapons Data Link (MN)
- X-band Thin Radar Array (SN)
- Shredder (MN)
- High Temperature Polymeric Matrix Composites (ML)
- High Durability Hot Exhaust Structures (ML)
- Affordable Responsive Space Lift (VA)
- Battlefield Air Operations Kit (MN)
- Advanced Multi-junction Solar Cells (VS)



Manufacturing Readiness

Current Planning Process



- ATD selection has been by TD
 - Primary Customer Base, CAT I ATDs
 - PR, SN, MN, VA, VS, and ML
 - Implement MRLs into five ATDs per quarter
 - Introduced MRLs to wide AFRL community
- Training ManTech personnel to conduct effective assessments
- Train IPT, conduct assessment, execute plan to reach target MRL
- Developing process with AFRL/XP for timely new ATD identification
 - ManTech to become an integral part of ATD selection process



ATDs Planned for FY06



- Choose ATDs based on similar technologies areas
- ATD candidate technology areas
 - Electronics
 - Propulsion & Power
 - Space
 - Structures
- Identify cross-cutting technologies
 - Develop ManTech program to satisfy several ATDs
 - Leverage on-going programs
- Planning a summer blitz to implement into several ATDs



FY06 ACAT Tactical Plan



- Per SAF/AQ tasking, select pilots with SAF/AQR
 - Need to manage with on-going ATD workload
- Convene experienced assessment team
 - Experience with assessment process
 - Subject matter expertise
 - Acquisition wing personnel and contractors
- Conduct MRAs on pilots – key technologies or components
 - E.g. F-22A, AMRAAM
- Develop/refine assessment process for acquisition programs
 - Will vary from ATD process and may be program specific
 - Dependent on current or target milestone
 - Significant program office involvement



MRA Deliverables



- Current MRL
 - Key risk areas
 - Driving issues
- Plan to obtain target MRL
 - Risk mitigation plans
 - Schedule
 - Funding
 - Contract modification language



Additional Information



- MRL definitions can be found at DAU web site:
 - https://acc.dau.mil/simplify/ev_en.php
 - Click on Production Quality & Manufacturing
 - Click on Manufacturing Readiness Assessments



In Closing



- MRL working definitions established
 - JDMTP on board
 - Exercising on ATDs and ACATs
 - But no formal policy yet
- MRL process established in AFRL ATDs
- Managing current manpower issues
- Initializing ACAT pilot efforts

Moving forward but still developing...